Instruction Manual and Operational Procedure

for

Model 829G Calibration Standard

Serial No. _____

RFL Industries, Inc.

Boonton, New Jersey, U. S. A.

Theory of Operation

Specifications

Initial Check-out

Calibration Source Operation

- Amperes A C
- Volts A C
- Amperes D C
- Volts D C
- Standard Resistances

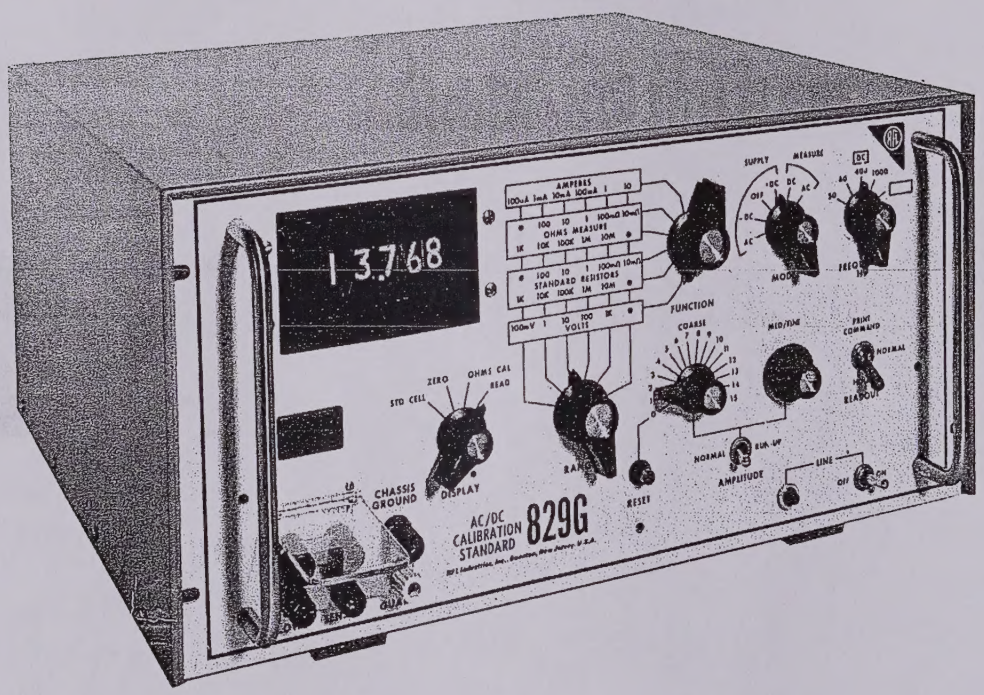
Measurement Standard Operation

- Amperes A C
- Volts A C
- Ohms A C
- Amperes D C
- Volts D C
- Ohms D C

Calibration

Maintenance

Replaceable Parts List



Model 829G AC-DC Calibration Standard.

THEORY OF OPERATION

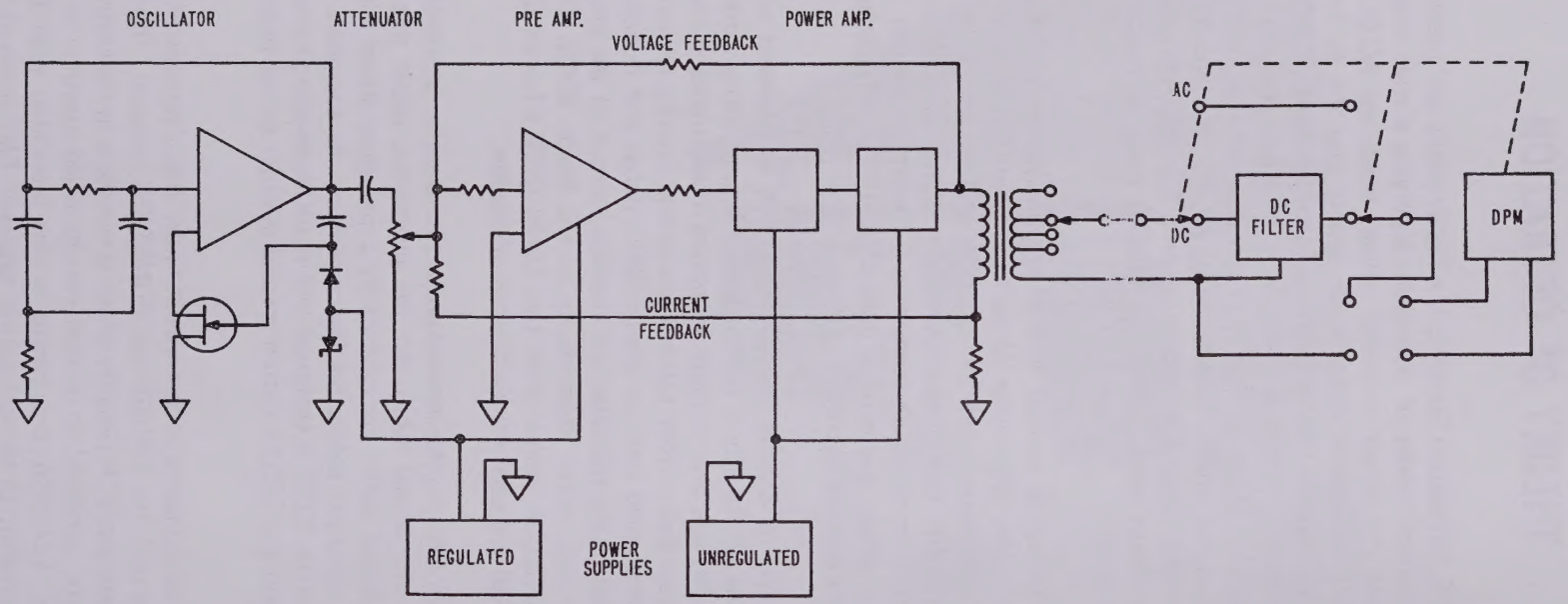
The Model 829G Calibration Standard is a highly stable and precise instrument capable of two distinct modes of operation; supplying a wide range of AC-DC voltage and current and preset resistance values; measuring AC-DC voltage and current of the same parameters which it can supply, plus the ability to measure a broad range of resistance values. In its source mode the Model 829G incorporates a bridged "T" oscillator utilizing an integrated circuit operational amplifier and an FET amplitude regulator. These circuits, in conjunction with appropriate frequency determining components, enable frequencies of 50, 60, 400 and 1000 Hz to be selected by means of a single front panel control. The 400 Hz frequency is used as the driving frequency when the Model 829G is operated in its DC mode to enable low ripple output.

The oscillator output is applied to a preamplifier/power amplifier through a three-stage Kelvin-Varley attenuator (Amplitude controls). Over-all voltage and current feedback is designed into the amplifier sections and roll-off control is incorporated to prevent high frequency bursts from occurring in the output waveform. The amplifier output is applied to a transformer which is capable of handling all output voltage and current, both AC and DC (the latter in conjunction with the appropriate rectifier circuits).

The precise value of output voltage or current is measured at the output terminals by means of the Model 829G digital readout instrumentation. Appropriate voltage dividers and four-terminal shunts are incorporated to enable accurate sensing of the voltage and current. Current and voltage limiting components, where necessary, are incorporated into the Model 829G Range and Function switching circuits. The output of the oscillator and the input circuit of the preamplifier are accessible through rear panel connections on the Model 829G. These provide necessary synchronization points when two Model 829G's (or an 829G plus an auxiliary AC source) are used for wattmeter calibration.

The Model 829G incorporates internal protective circuitry to provide protection for the operator, the Model 829G and the instrument under test. The output terminals of the Model 829G are covered by a plexiglass shield which must be lowered over the terminals before the instrument can be energized. Raising this shield while the Model 829G is energized will result in de-energization; the shield must be lowered and the RESET button pressed in order to reactivate the voltage or current.

The possibility of damaging an instrument under test is minimized by interlock circuitry associated with the RANGE and FUNCTION selectors. The Model 829G is protected by spark-gap/SCR circuitry which is energized in the event of excessive voltage (transient or constant) in critical circuits when operated by its internal oscillator/amplifier. The SCR trip circuit is also associated with the Sense to Chassis Ground terminals to protect against excessive EMF levels at these points. Overheating of the Model 829G can occur if the instrument is operated in

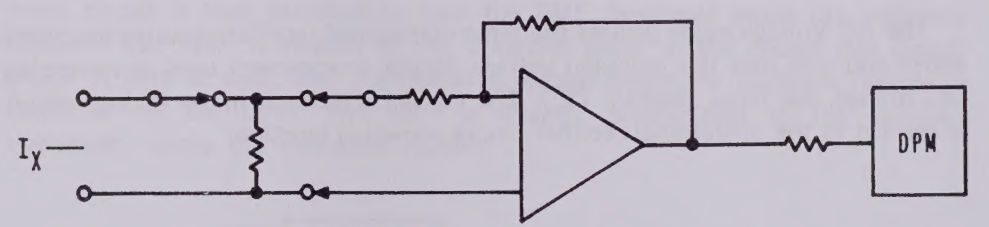


A. Block Diagram: Model 829G AC-DC Current/Voltage Supply Mode.

excessively high ambient temperature environments or if an attempt is made to work at overloaded output conditions for any length of time. A snap action temperature sensor initiates if the Model 829G heat sinks exceed 125°C. Once tripped, the self-restoring sensor prevents operation of the instrument until the heat sinks return to normal temperature.

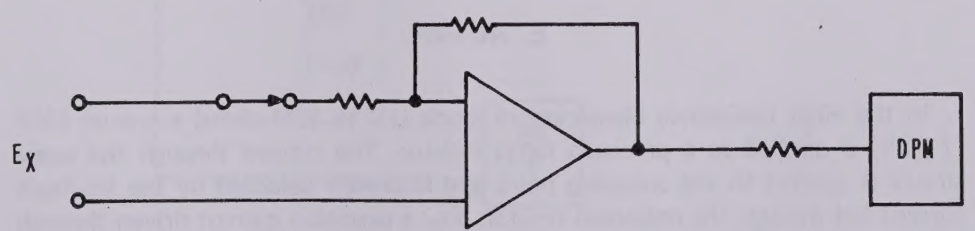
In the Measurement mode the Model 829G utilizes its switching circuitry and precision measurement section consisting of the digital panel meter, precision shunts and multipliers, operation amplifier for DC functions and an operational rectifier for AC functions.

When measuring DC current, the effective circuit is that shown in block diagram (B). The input circuits of the operational amplifier are connected across a precision resistor having a value that will develop a precise 100 mV at an applied full-scale range value. The voltage from the precision resistor is applied to the operational amplifier circuit which has its negative input at a summing point held to zero voltage. The developed EMF is of opposing polarity and equal in magnitude (at full-scale) to the EMF of the precision feedback circuit; therefore, the EMF at the operational amplifier output is precisely related to the current applied to the Model 829G terminals.



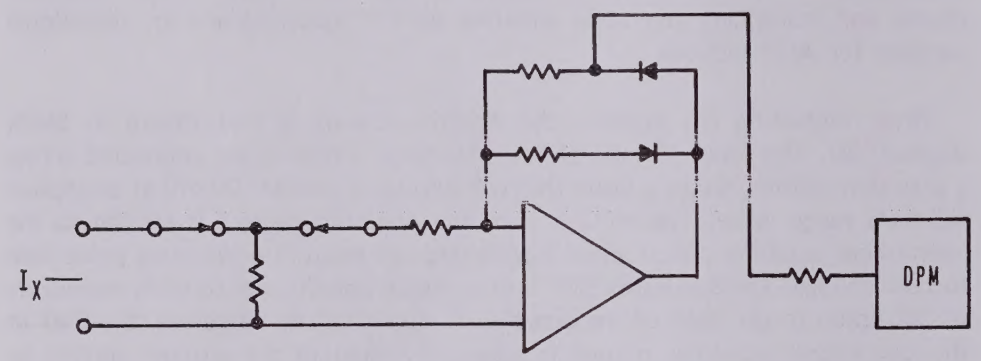
B. Direct Current.

DC voltage measurement, block diagram (C) is similar to DC current measurement. The negative input of the operational amplifier is a current summing point held at zero voltage. The 0.1 mA current through the precision input divider must be equal and opposite to the current from the precision feedback circuit. The EMF developed at the operational amplifier output is directly related to the voltage applied to the Model 829G input terminals.



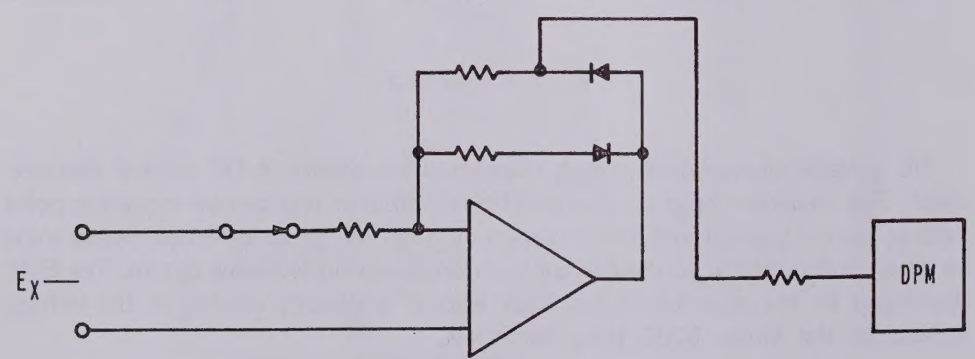
C. DC EMF.

In the Alternating Current mode of operation, the operational amplifier and two feedback paths with series rectifiers form an operational rectifier. The operational amplifier generates EMF as required to compensate for diode EMF drop. Since one end of the feedback resistor is at zero potential, the current through the feedback resistor, R_f causes a precision voltage to be developed at the DPM input. The same four-terminal resistors used in the Direct Current mode are used as input sensing elements, see block diagram (D).



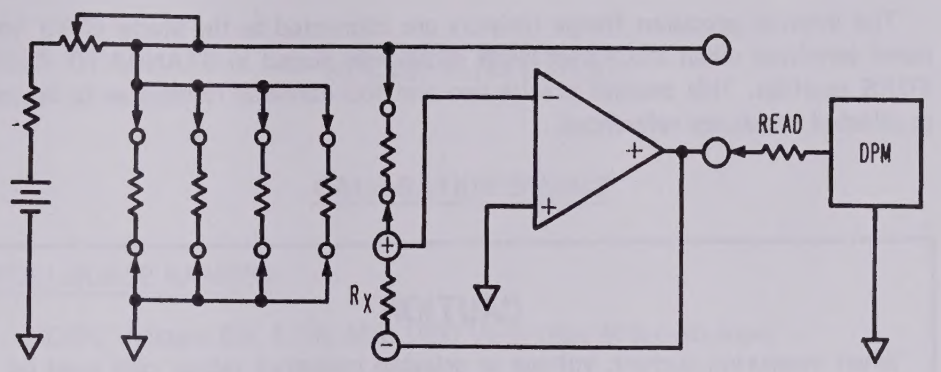
D. Alternating Current.

The AC Voltage mode utilizes the same operational rectifier circuitry described above and also uses the precision voltage divider arrangement used in measuring DC voltage, see block diagram (E). The current developed in the divider circuit is applied to the operational rectifier circuit summing junction.



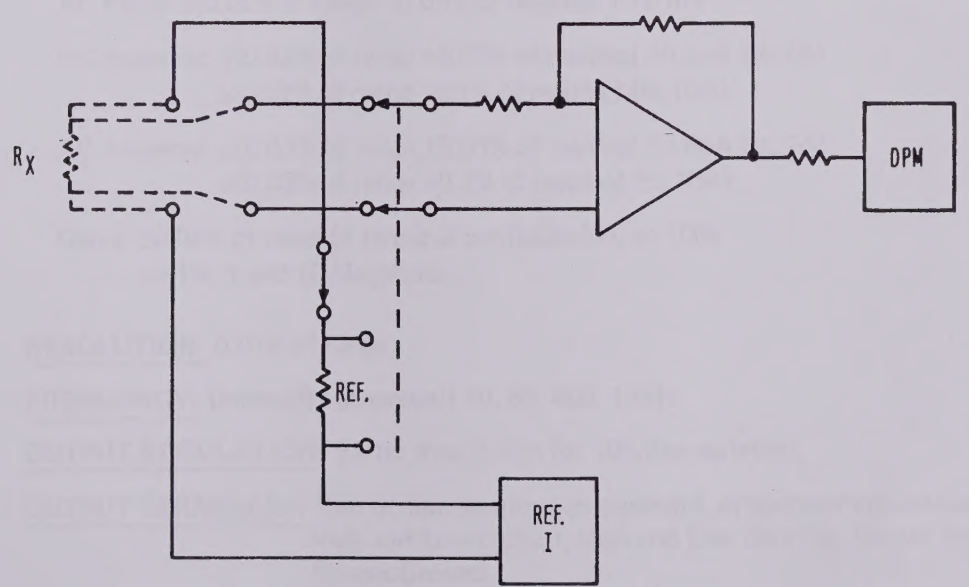
E. AC EMF.

In the High Resistance Measurement mode (1K to 10M ohms) a precise EMF (1 Volt) is applied to a precision range resistor. The current through the range circuit is applied to the summing point and is exactly balanced by the feedback current fed through the unknown resistor. For a precision current driven through the unknown resistor, a voltage proportional to the unknown resistance is developed and read by the DPM.



F. Ohms Measurement.

Low resistance measurements utilize four-terminal resistance techniques. Selection of the Model 829G range automatically switches an appropriate four-terminal precision resistor into the measurement circuit. The external four-terminal resistance which is to be measured is connected as a series extension to the Model 829G four-terminal standard resistor. A full-scale range current (i.e. 10 mA, 100 mA, etc.) is applied through the series circuit and held constant. The measurement circuit is then switched to read the EMF developed across the unknown resistor. This EMF is applied to the summing point in the operational circuit which is held at zero, and the precision voltage across the feedback resistor is measured by the DPM. The EMF is directly proportional to the voltage developed across the unknown resistor.



G. Low Ohms Measurement.

The internal precision Range resistors are connected to the Model 829G front panel terminals when the FUNCTION selector is placed in STANDARD RESISTORS position. This enables precise two and four-terminal resistances to be used as selected resistance references.

CAUTION

When measuring current, voltage or selected resistance values, care must be exercised not to exceed the current or voltage specified for the range in use. Excessive input can damage these precision components.

An internal (or external) standard cell should be used to check the full scale accuracy of the Model 829G DPM. This check may be performed on a daily or weekly basis, depending on the accuracy required of the over-all calibration system.

If it is desired to measure the resistance of a galvanometer, switch to the appropriate RANGE and FUNCTION before connecting meter.

Do not connect meter prior to selecting FUNCTION and RANGE, as it is possible to damage a galvanometer by switching through an inappropriate resistance measure range.

SPECIFICATIONS

CALIBRATION SOURCE

FULL-SCALE RANGES:

AC-DC Voltage: 0.1, 1, 10, 100, 1000 Volts (plus 40% overrange)

Max. Burden: 0.03A @ 1000V AC-DC
0.2A @ 100V AC-DC
2.0A @ 10V AC-DC
5A @ 1V AC
1A @ 1V DC
0.5A @ 0.1V AC-DC

AC-DC Current: 100μA, 1 mA, 10 mA, 100 mA, 1A, 10A (plus 40% overrange)

Max. Compliance: 2 Volts @ 10 Amperes

Ohms: (cardinal values only) 0.01, 0.1, 1, 10, 100, 1k, 10k, 100k, 1M and 10M

ACCURACY: (for 100% to 10% of full-scale range)

DC Volts: ±(0.02% of range +0.03% of reading) +0.2 mV

AC Volts: ±(0.03% of range +0.05% of reading) +0.5 mV

DC Amperes: ±(0.02% of range +0.03% of reading) +0.2μA (to 1A)
±(0.02% of range +0.1% of reading) (to 10A)

AC Amperes: ±(0.03% of range +0.05% of reading) +0.5μA (to 1A)
±(0.03% of range +0.2% of reading) (to 10A)

Ohms: ±0.06% of value (4 terminal configuration) to 100k
±0.1%, 1 and 10 Megohms

RESOLUTION: 0.01% of range

FREQUENCY: (internally generated) 50, 60, 400, 1 kHz

OUTPUT REGULATION: Better than 0.05% for 10% line variation.

OUTPUT TERMINALS: Two or four-terminal arrangement, at operator's discretion. High and Low Output, High and Low Sensing, Circuit and Chassis Ground.

MEASUREMENT STANDARD

FULL-SCALE RANGES: (plus 40% overrange)

AC-DC Voltage: 0.1, 1, 10, 100, 1000 Volts (input impedance: 10k ohms/volt)

AC-DC Current: 100μA, 1 mA, 10 mA, 100 mA, 1A, 10A (input impedance varies with range: 0.1 to 20k ohms)

Ohms Range: Low: 0.01, 0.1, 1, 10, 100 ohms (AC & DC)
High: 1k, 10k, 100k, 1M, 10M ohms (DC only)

Frequency Response: 50 Hz to 1 kHz

ACCURACY: (for 100% to 10% of full-scale range)

DC Volts: ±(0.02% of range +0.03% of reading) +0.2 mV

AC Volts: ±(0.03% of range +0.05% of reading) +0.5 mV

DC Amperes: ±(0.02% of range +0.03% of reading) +0.2μA (to 1A)
±(0.02% of range +0.1% of reading) (to 10A)

AC Amperes: ±(0.03% of range +0.05% of reading) +0.5μA (to 1A)
±(0.03% of range +0.2% of reading) (to 10A)

AC Ohms: (Low Range Only) ±(0.05% of range +0.05% of reading) +100μ ohms

DC Ohms - Low Range: ±(0.02% of range +0.03% of reading) +100μ ohms

DC Ohms - High Ranges: ±(0.02% of range +0.03% of reading) +0.1 ohm (to 100k)
±(0.02% of range +0.1% of reading) (to 1 Meg)
±(0.02% of range +0.2% of reading) (to 10 Meg)

SIZE: 19" W x 8¾" H x 23" D (48.3 x 22.2 x 58 cm)

WEIGHT: 98 pounds (44.5 kilograms)

POWER LINE REQUIREMENTS: 115 or 230 Volts, 50/60 Hz

Maximum Demand: 250 watts @ 60 Hz

NOTE

For optimum accuracy in all modes of operation, it is advised that the DPM zero "toggle" be checked and reset (if necessary) periodically, i.e. daily. Refer to Calibration paragraphs 1 and 4.

INITIAL CHECK-OUT

1. Unless tagged otherwise, the Model 829G is internally connected for 115 volt line operation

2. Before plugging the line cord into power receptacle, set the Model 829G controls as follows: LINE switch to OFF, READOUT switch to NORMAL, FREQUENCY selector to 400 Hz, MODE selector to OFF, AMPLITUDE switch to NORMAL, COARSE and MED/FINE controls full counterclockwise, FUNCTION selector to VOLTS, RANGE selector to the 1 VOLT position, DISPLAY selector to READ, and plexiglass safety shield into its lowered position. Plug line cord into appropriate power receptacle and place LINE switch in ON position. Allow approximately one-half hour warm-up prior to operation for maximum stability.

3. Place DISPLAY selector to ZERO position and check for zero (±3 last place digit) readout of digital display.

4. Place DISPLAY selector in STD CELL position (if standard cell check is desired). If Model 829G is equipped with an internal cell, the digital display should indicate the appropriate EMF (the EMF of a cell furnished with the Model 829G will be found on the Certificate inside this manual). If an external standard cell is used for calibration check, see procedure under CALIBRATION in this manual.

5. Strap HIGH OUTPUT to HIGH SENSE and LOW OUTPUT to LOW SENSE and connect a shorting strap from HIGH to LOW OUTPUT. Set COARSE AMPLITUDE control to zero. Set MODE selector to +DC (SUPPLY). Set DISPLAY selector to READ position. Lower plexiglass shield until it engages its associated interlocking switch. Check for digital readout of .0000 ±3 last place digit.* Remove shorting strap from HIGH to LOW OUTPUT.

6. If any of the initial checks performed above fail to fall within the specified readings, adjust appropriate controls as described under CALIBRATION in this manual.

See "Interlock Reset Operation," page 10 for details of Reset Operation.

CAUTION

HIGH VOLTAGE

The Model 829G AC-DC Calibration Standard can generate voltages of a hazardous and/or lethal nature. A protective, electrically interlocked plexiglass shield is provided over the Voltage/Current Output terminals. Lowering the shield to its maximum "down" position allows the output circuit to be energized. When the shield is raised, even slightly, from its full "down" position, a drop-out relay automatically disconnects voltage or current from the output terminals. Do not attempt to defeat the purpose of this protective interlock.

GUARD CIRCUIT OPERATION

NOTE: The following precautions may be disregarded when operating the Model 829G as a normal circuit grounded instrument, i.e. when the CHASSIS GROUND, GUARD, LOW SENSE and LOW OUTPUT are strapped together.

The LOW SENSE circuit and the GUARD circuit are internally connected by back to back diodes. Potential difference between these two terminals should never exceed ±0.75 volt. The LOW SENSE circuit is connected to CHASSIS by a solid-state trigger circuit. Potential difference between these two terminals must never exceed ±40 volts. If the GUARD to CHASSIS potential is excessive, EXTENSIVE DAMAGE TO THE DIGITAL READOUT AND/OR CONVERTER CIRCUITRY CAN RESULT.

INTERLOCK RESET OPERATION

If the RANGE, FUNCTION or MODE selector position is changed while the Model 829G is energized (COARSE AMPLITUDE control run-up to any position above zero) the Model 829G will immediately become de-energized and the RESET push button will become illuminated. Under these conditions, output voltage or current will drop to zero. The same condition will automatically occur if the output voltage exceeds its 40% overrange to any great extent or if extensive transient pulses cause momentary peak EMF beyond the 40% region.

Re-energization of the instrument may be accomplished in either of two ways. The RESET button may be pressed, all controls remaining in their previously established positions, and the voltage or current will be re-established to the previous levels. Or, the COARSE AMPLITUDE control may be returned to its zero position, in which case the interlock circuit will immediately re-engage. NOTE: If the COARSE AMPLITUDE control is at zero and the FUNCTION, RANGE or MODE selector position is changed, the interlock will operate, turning off the amplifier input. In this case pressing the RESET button will NOT re-engage the interlock. It is necessary to either rotate the COARSE AMPLITUDE control up one step and then back to zero, at which time the circuit will automatically become engaged, or the COARSE AMPLITUDE control may be advanced any number of positions from zero and pressing the RESET button will result in re-establishment of voltage or current output.

CALIBRATION SOURCE OPERATION

AMPERES AC

Ranges: 0 to 100μA, 1 mA, 10 mA, 100 mA, 1A, 10A (plus 40% overrange)

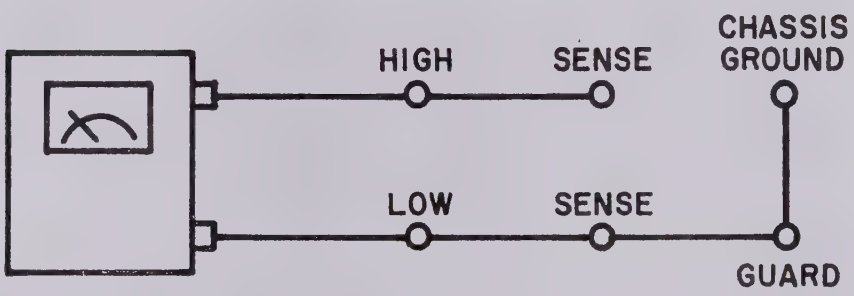
Maximum Compliance: 2 volts

Accuracy: **(for 100% to 10% of full-scale range)**

(up to 1A) ±(0.03% of range +0.05% of reading) +0.5μA

(up to 10A) ±(0.03% of range +0.2% of reading)

TERMINAL CONNECTIONS



OPERATION PROCEDURE

1. Set MODE selector to OFF, FUNCTION selector to AMPERES, DISPLAY selector to READ, RANGE selector to full-scale current range desired, READ-OUT switch to NORMAL, AMPLITUDE switch to NORMAL with COARSE and MED/FINE controls full counterclockwise, and FREQUENCY selector to desired frequency setting.

2. Raise protective plexiglass shield and connect instrument which is to be tested to appropriate terminals (see illustration above). After completing connections, lower plexiglass shield until its associated interlocking switch engages.

3. Place MODE selector to AC (SUPPLY) position.

   Calibration of the instrument under test may be accomplished in either of two ways: The Model 829G may be adjusted to provide a desired output as indicated by the digital display and the indication of the instrument under test noted, or, the output amplitude of the Model 829G may be adjusted until the instrument under test indicates the desired value and the applied current is noted on the Model 829G readout display.

4. Advance COARSE AMPLITUDE control one step and then return it to zero to engage interlock circuitry. Advance MED/FINE control approximately half its rotation. Advance COARSE AMPLITUDE control while observing indication of the instrument under test (or the Model 829G readout). Adjust both COARSE and MED/FINE AMPLITUDE controls until desired indication is achieved. The Model 829G display indicates directly the value of current applied through the output terminals. It should be noted that the display indication lags a change in amplitude adjustment by a second or two.

5. In some instances it may be desirable to retain the Model 829G readout while its indication is noted and manually recorded. This may be accomplished by placing the READOUT switch in HOLD position. This retains the readout which is present at the instant the switch is placed in HOLD; however, it does not lock the output amplitude of the Model 829G. Return READOUT switch to NORMAL after completing the test.

6. When testing analog meters, it is generally advisable to check the movement for friction or bearing sticks. This may be accomplished with the Model 829G in the following manner:

   Adjust COARSE and MED/FINE AMPLITUDE controls for full-scale indication of meter under test. Place AMPLITUDE switch in RUN-UP position. The MED/FINE control may now be used to continuously adjust meter deflection from zero to full-scale or conversely from full-scale to zero. In some cases it may be necessary to advance COARSE control.

   Return AMPLITUDE control switch to NORMAL after completion of run-up tests.

7. Upon completion of calibration operations, return AMPLITUDE controls to full counterclockwise positions, place MODE selector in OFF, raise protective plexiglass shield and disconnect tested instrument.

PRECAUTIONARY NOTES

Interlock Operation

If the RANGE, FUNCTION or MODE selector position is changed, or if the plexiglass shield is raised while the Model 829G is energized, the instrument will immediately become de-energized and output will drop to zero. Re-energization may be accomplished by pressing the RESET button, in which case full energization will be realized, or the COARSE AMPLITUDE control may be returned to zero position and again advanced. In the case of the shield causing interlock cutout, the shield must be lowered until its interlocking switch engages, following which the RESET button must be pressed or the COARSE control returned to zero position.

VOLTS AC

Ranges: 0 to 0.1V, 1V, 10V, 100V, 1000V (plus 40% overrange)

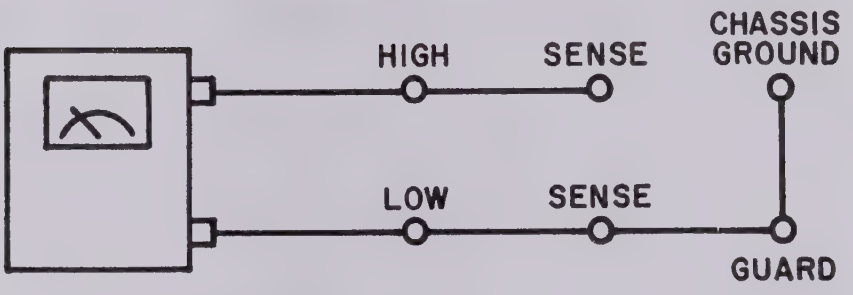
Maximum Burden:

0.03A	@	1000 volts
0.2A	@	100 volts
2.0A	@	10 volts
5.0A	@	1 volt
0.5A	@	0.1 volt

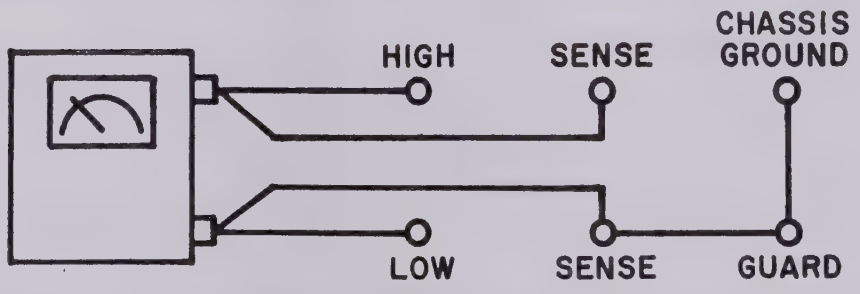
Accuracy: (for 100% to 10% of full-scale range)

±(0.03% of range +0.05% of reading) +0.5mV

TERMINAL CONNECTIONS



Two-Terminal Configuration (for low burden instruments).



Four-Terminal Configuration (remote sensing).

OPERATIONAL PROCEDURE

1. Set MODE selector to OFF, FUNCTION selector to VOLTS, DISPLAY selector to READ, RANGE selector to full-scale range desired, READOUT switch to NORMAL, AMPLITUDE switch to NORMAL, COARSE and MED/FINE controls full counterclockwise, and FREQUENCY selector to desired frequency.

2. Raise protective plexiglass shield and connect instrument which is to be tested to appropriate terminals. After completing connections, lower plexiglass shield until its associated interlocking switch engages.

3. Place MODE selector in AC (SUPPLY) position.

   Calibration of the instrument under test may be accomplished in either of two ways: The Model 829G may be adjusted to provide a desired output as indicated by the digital display and the indication of the instrument under test noted, or, the output amplitude of the Model 829G may be adjusted until the instrument under test indicates the desired value and the applied voltage is noted on the Model 829G digital display.

4. Advance COARSE AMPLITUDE control one step and then return it to zero to engage interlock circuitry. Advance MED/FINE control approximately half of its rotation. Advance COARSE AMPLITUDE control while observing indication of instrument under test (or Model 829G readout). Adjust both COARSE and MED/FINE controls until desired indication is achieved. The Model 829G display indicates directly the value of voltage applied to the output terminals. It should be noted that the display indication lags a change in amplitude adjustment by a second or two.

5. In some instances it may be desirable to retain the Model 829G readout while its indication is noted and manually recorded. This may be accomplished by placing the READOUT switch in HOLD position. This retains the readout which is present at the instant the switch is placed in HOLD; however, it does not lock the output amplitude of the Model 829G. Return READOUT switch to NORMAL after completing the test.

6. When testing analog meters, it is generally advisable to check the movement for friction or bearing sticks. This may be accomplished by the Model 829G in the following manner:

   Adjust COARSE and MED/FINE AMPLITUDE controls for full-scale indication of meter under test. Place AMPLITUDE switch in RUN-UP position. The MED/FINE control may now be used to continuously adjust meter deflection from zero to full-scale or conversely from full-scale to zero. In some cases it may be necessary to advance COARSE control.

   Return AMPLITUDE control switch to NORMAL after completion of run-up tests.

7. Upon completion of calibration operations, return AMPLITUDE controls to full counterclockwise positions, place MODE selector to OFF, raise protective plexiglass shield and disconnect tested instrument.

PRECAUTIONARY NOTES

Interlock Operation

If the RANGE, FUNCTION or MODE selector position is changed, or if the plexiglass shield is raised while the Model 829G is energized, the instrument will immediately become de-energized and output will drop to zero. Re-energization may be accomplished by pressing the RESET button, in which case full energization will be realized, or the COARSE AMPLITUDE control may be returned to zero position and again advanced. Where raising the shield causes interlock cutout, the shield must first be lowered and the RESET button pressed or the COARSE control returned to zero position.

NOTES

AMPERES DC

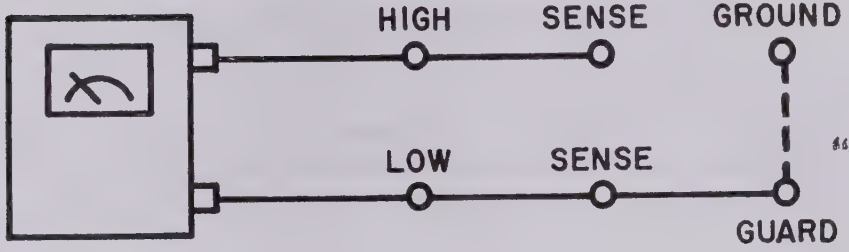
Ranges: 0 to 100μA, 1mA, 10mA, 100mA, 1A, 10A (plus 40% overrange)

Maximum Compliance: 2 volts

Accuracy: **(for 100% to 10% of full-scale range)**

(to 1A) ±(0.02% of range +0.03% of reading) +0.2μA
(to 10A) ±(0.02% of range +0.1% of reading)

TERMINAL CONNECTIONS



CAUTION
See Page 10
"Guard Circuit"

OPERATIONAL PROCEDURE

1. Set MODE selector to OFF, FUNCTION selector to AMPERES, DISPLAY selector to READ, RANGE selector to full-scale current range desired, READ-OUT switch to NORMAL, AMPLITUDE switch to NORMAL, COARSE and MED/FINE AMPLITUDE controls full counterclockwise, and FREQUENCY selector to 400 Hz.

2. Raise protective plexiglass shield and connect instrument which is to be tested to appropriate terminals (see illustration above). After completing connections lower plexiglass shield until its associated interlocking switch engages.

3. Place MODE selector to appropriate DC (SUPPLY) position.

   Calibration of the instrument under test may be accomplished in either of two ways: The Model 829G may be adjusted to provide a desired output as indicated by the digital display and the indication of the instrument under test noted, or, the output amplitude of the Model 829G may be adjusted until the instrument under test indicates the desired value and the applied current is noted on the Model 829G readout display.

4. Advance COARSE AMPLITUDE control one step and then return it to zero to engage interlock circuitry. Advance MED/FINE control approximately half of its rotation. Advance COARSE AMPLITUDE control while observing indication of instrument under test (or Model 829G readout). Adjust both COARSE and MED/FINE controls until desired indication is achieved. The Model 829G

display indicates directly the value of current applied through the output terminals. It should be noted that the display indication lags a change in amplitude adjustment by a second or two.

5. In some instances it may be desirable to retain the Model 829G readout while its indication is noted and manually recorded. This may be accomplished by placing the READOUT switch in HOLD position. This retains the readout which is present at the instant the switch is placed in HOLD; however, it does not lock the output amplitude of the Model 829G. Return READOUT switch to NORMAL after completion of this test.

6. When testing analog meters, it is generally advisable to check the movement for friction or bearing stick. This may be accomplished by the Model 829G in the following manner:

   Adjust COARSE and MED/FINE AMPLITUDE controls for full-scale indication of meter under test. Place AMPLITUDE switch in RUN-UP position. The MED/FINE control may now be used to continuously adjust meter deflection from zero to full-scale or conversely from full-scale to zero. In some cases it may be necessary to advance COARSE control.

   Return AMPLITUDE control switch to NORMAL after completion of RUN-UP tests.

7. Upon completion of calibration operations, return AMPLITUDE controls to full counterclockwise positions, place MODE selector to OFF, raise protective plexiglass shield and disconnect tested instrument.

PRECAUTIONARY NOTES

Interlock Operation

If the RANGE, FUNCTION or MODE selector position is changed, or if the plexiglass shield is raised while the Model 829G is energized, the instrument will immediately become de-energized and output will drop to zero. Re-energization may be accomplished by pressing the RESET button, in which case full energization will be realized, or the COARSE AMPLITUDE control may be returned to zero position and again advanced. Where raising the protective shield causes interlock cutout, the shield must be returned to its lowered position before reset of the interlock circuit can be accomplished.

VOLTS DC

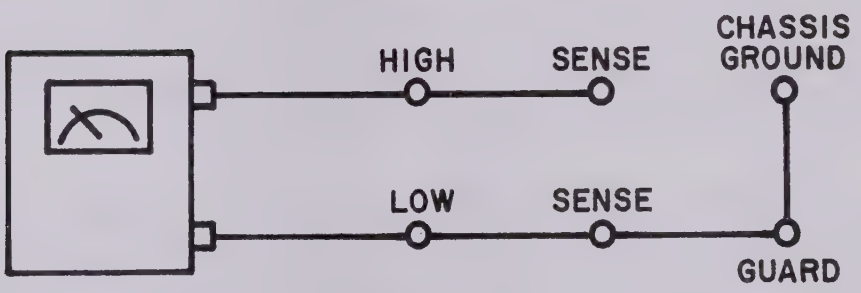
Ranges: 0 to 0.1V, 1V, 10V, 100V, 1000V

Maximum Burden: 0.03A @ 1000V
0.2A @ 100V
2.0A @ 10V
1.0A @ 1V
0.5A @ 0.1V

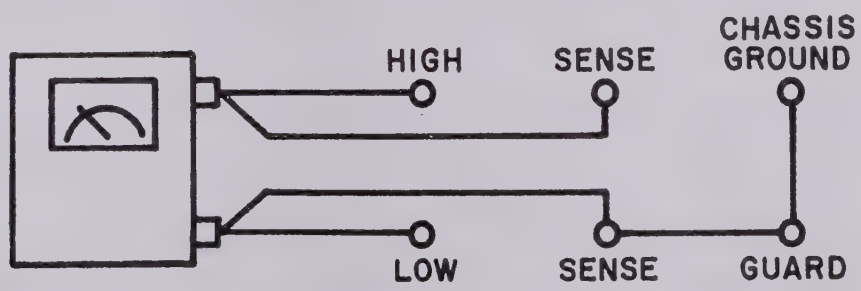
Accuracy: (for 100% to 10% of full-scale range)

±(0.02% of range +0.03% of reading) +0.2mV

TERMINAL CONNECTIONS



Two-Terminal Configuration (for low burden instruments).



Four-Terminal Configuration (remote sensing).

OPERATIONAL PROCEDURE

1. Set MODE selector to OFF, FUNCTION selector to VOLTS, DISPLAY selector to READ, RANGE selector to full-scale voltage range desired, READ-OUT switch to NORMAL, AMPLITUDE switch to NORMAL, COARSE and MED/FINE AMPLITUDE controls full counterclockwise, and FREQUENCY selector to DC position.

2. Raise protective plexiglass shield and connect instrument which is to be tested to appropriate terminals (see illustration, page 19). After completing connections, lower plexiglass shield until its associated interlocking switch engages.

3. Place MODE selector to + or – DC (SUPPLY) position.

   Calibration of the instrument under test may be accomplished in either of two ways: The Model 829G may be adjusted to provide a desired output as indicated by the digital display and the indication of the instrument under test noted, or, the output amplitude of the Model 829G may be adjusted until the instrument under test indicates the desired value and the applied voltage is then noted on the Model 829G readout display.

4. Advance COARSE AMPLITUDE control one step and then return it to zero to engage interlock circuitry. Advance MED/FINE control approximately half its rotation. Advance COARSE AMPLITUDE control while observing indication of the instrument under test (or the Model 829G readout). Adjust both COARSE and MED/FINE AMPLITUDE controls until desired indication is achieved. The Model 829G display indicates directly the value of EMF applied to the panel output terminals. It should be noted that the display indication lags a change in amplitude adjustment by a second or two.

5. In some instances it may be desirable to retain the Model 829G readout while its indication is noted and manually recorded. This may be accomplished by placing the READOUT switch in HOLD position. This retains the readout which is present at the instant the switch is placed in HOLD; however, it does not lock the output amplitude of the Model 829G. Return READOUT switch to NORMAL after completing the test.

6. When testing analog meters, it is generally advisable to check the movement for friction or bearing sticks. This may be accomplished by the Model 829G in the following manner:

   Adjust COARSE and MED/FINE AMPLITUDE controls for full-scale indication of meter under test. Place AMPLITUDE switch in RUN-UP position. The MED/FINE control may now be used to continuously adjust meter deflection from zero to full-scale or conversely from full-scale to zero. In some cases it may be necessary to advance COARSE control.

   Return AMPLITUDE control switch to NORMAL after completion of RUN-UP tests.

7. Upon completion of calibration operations, return AMPLITUDE controls to full counterclockwise positions, place MODE selector to OFF, raise protective plexiglass shield and disconnect tested instrument.

PRECAUTIONARY NOTES

Interlock Operation

If the RANGE, FUNCTION or MODE selector position is changed, or if the plexiglass shield is raised while the Model 829G is energized, the instrument will immediately become de-energized and output will drop to zero. Re-energization may be accomplished by pressing the RESET button, in which case full energization will be realized, or the COARSE AMPLITUDE control may be returned to zero position and again advanced. Where raising the protective shield causes interlock cutout, the shield must be returned to its lowered position before reset of interlock circuit can be accomplished.

STANDARD RESISTANCES

Fixed Values:

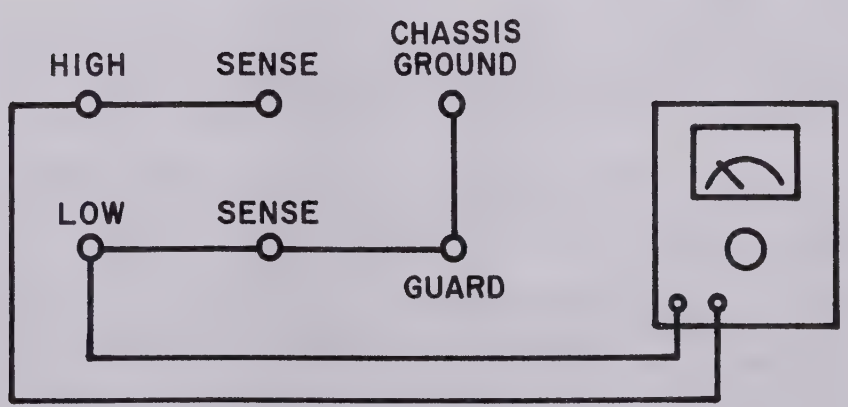
Low Range: 0.01, 0.1, 1, 10 and 100 ohms
High Range: 1k, 10k, 100k, 1M and 10M ohms
Accuracy: ±0.06% of value (based on 4-terminal measurement for values of 0.01 through 100 ohms)

Maximum Power Dissipation:

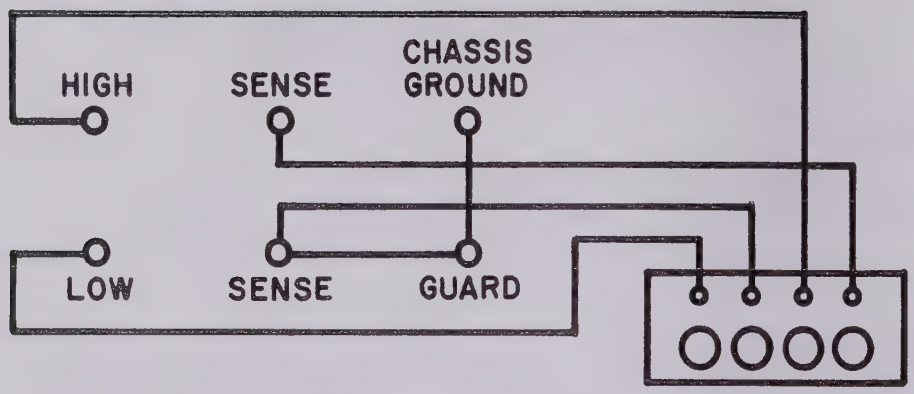
Value	Voltage	Current	Watts
0.01 ohm	0.14V	14.0A	1.96
0.1 ohm	0.14V	1.4A	0.19
1.0 ohm	0.316V	0.316A	0.10
10 ohms	1.0V	0.1A	0.10
100 ohms	3.16V	0.032A	0.10
1k ohms	10V	0.01A	0.10
10k ohms	31.6V	0.003A	0.10
100k ohms	100V	0.001A	0.10
1M ohms	316V	0.3 mA	0.10
10M ohms	1.4kV	0.1 mA	0.10

NOTE: When operating in STANDARD RESISTANCES the DPM has no function in relation to the STANDARD RESISTANCE.

TERMINAL CONNECTIONS



Two-Terminal Configuration: Ohmmeter Being Calibrated.



Four-Terminal Configuration: Resistance Bridge Being Calibrated.

OPERATIONAL PROCEDURE

Low Value Ranges:

For values of 0.01 ohm to 100 ohms where the maximum accuracy of +0.06% is required, a four-terminal measurement technique should be used. An exception to this is where a relatively low accuracy instrument (such as a 3% multirange VOM) is to be calibrated. In the latter case, a two-terminal configuration should be used.

1. Place MODE selector in OFF position, AMPLITUDE controls full counterclockwise, FUNCTION selector to low-value ohm designation in STANDARD RESISTORS range, and RANGE selector to desired ohmic value.

2. Raise plexiglass protective shield and connect resistance measuring instrument to Model 829G terminals (see illustration above, Four-Terminal Configuration). Model 829G need not be plugged into power line for operation as a resistance standard.

3. Operate the resistance measuring instrument in its normal manner to verify its accuracy relative to the values and accuracy of the Model 829G standard resistors.

High Value Ranges:

1. Place MODE selector to OFF, AMPLITUDE controls full counterclockwise, FUNCTION selector to high-value ohms designations in STANDARD RESISTORS range, and RANGE selector to desired ohmic value.

2. Raise plexiglass protective shield and connect the resistance measurement instrument which is to be tested to the Model 829G terminals (see illustration, page 23, under Two-Terminal Configuration).

3. Operate the resistance measurement instrument in its normal manner to verify its accuracy relative to the value and accuracy of the resistance standards incorporated in the 829G.

4. NOTE: When using a line operated bridge, disconnect Model 829G from AC line supply.

MEASUREMENT STANDARD OPERATION

AMPERES AC

Full-Scale Ranges: (plus 40% overrange)

0 to 100μA, 1 mA, 10 mA, 100 mA, 1A, 10A

Range Burdens: (excluding connecting leads)

Full-Scale Range	Ohms	Burden Volts*	VA*
100μA	21k	2.1	0.00021
1 mA	2.1k	2.1	0.0021
10 mA	210	2.1	0.021
100 mA	21.2	2.1	0.21
1A	2.13	2.13	2.13
10A	0.2	2.13	21.3

** Indicates load at full-scale range (not at overrange conditions). Do not exceed full-scale range value by more than 40%. Excess current can result in damage to precision shunts.*

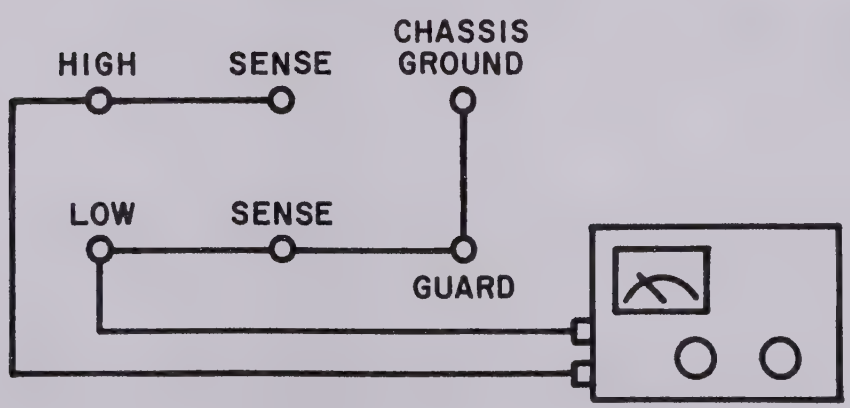
Accuracy: (for 100% to 10% of full-scale range)

(To 1A) ±(0.03% of range +0.05% of reading) +0.5μA

(To 10A) ±(0.03% of range +0.2% of reading)

Frequency Response: 50 - 1000 Hz

TERMINAL CONNECTIONS



Current Source Being Calibrated.

OPERATIONAL PROCEDURE

1. Place READOUT switch in NORMAL position, MODE selector to OFF, AMPLITUDE controls full counterclockwise, FUNCTION selector to AMPERES, RANGE selector to desired range and DISPLAY selector to READ, FREQUENCY selector is not used in this mode of operation.

2. Connect the de-energized source which is to be calibrated to the Model 829G terminals (see illustration, page 25). Raise protective plexiglass shield to facilitate connecting leads. Shield must be lowered until its associated interlocking switch engages before measurement operate can be continued.

3. Place MODE selector to AC (MEASURE). If interlock circuit is activated (RESET push button lighted) it will be necessary to either press the RESET button or advance the COARSE AMPLITUDE control one step and then return it to zero in order to deactivate the circuit.

4. Energize the current source which is to be calibrated. Measurement may be performed in either of two ways: The source may be adjusted to a desired level and the resultant current read from the Model 829G readout, or the source may be adjusted until the Model 829G display indicates a desired value and then the current indication at the source noted. Note: The Model 829G readout display may lag a change in amplitude adjustment of the source by a second or two. In some instances it may be desirable to hold the readout display while the indication is noted and manually recorded. This can be achieved by placing the READOUT switch in HOLD at which time the readout present at the instant the switch is closed will be retained. Return the READOUT switch to NORMAL after completion of observations.

PRECAUTIONARY NOTE

Overrange

Do not exceed rated full-scale range current by more than 40%. Failure to observe this precaution can result in damage to the Model 829G components.

VOLTS AC

Full-Scale Ranges: 0 to 0.1, 1, 10, 100, 1000 Volts (plus 40% overrange)

Input Impedance: 10k ohms/volt

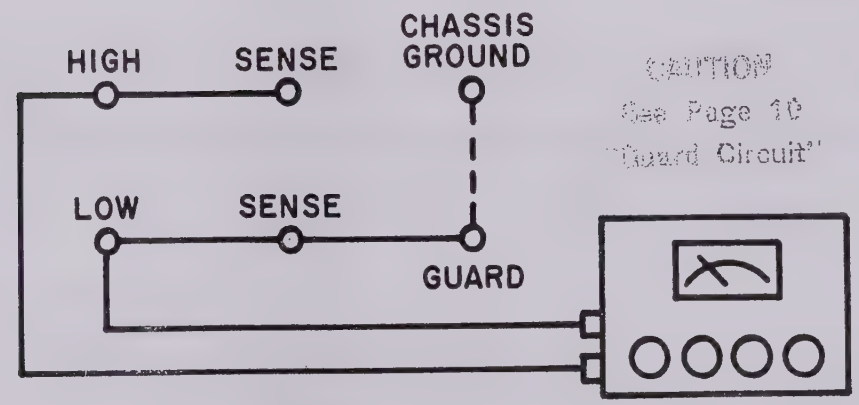
Accuracy: (for 100% to 10% of full-scale range)

±(0.03% of range +0.05% of reading) +0.5 mV

Frequency Response: 50 Hz to 1 kHz

TERMINAL CONNECTIONS

Dashed lines indicate optional connections.
Solid lines indicate mandatory connections.



Voltage Source Being Calibrated.

OPERATIONAL PROCEDURE

1. Place READOUT switch in NORMAL position, MODE selector to OFF, AMPLITUDE controls full counterclockwise, AMPLITUDE switch to NORMAL, FUNCTION selector to VOLTS, RANGE selector to desired range and DISPLAY selector to READ. The FREQUENCY selector is not used in this mode of operation.

2. Connect the de-energized source which is to be measured to the Model 829G terminals (see illustration above). Raise protective plexiglass shield to facilitate connecting leads. Shield must be lowered until its associated interlocking switch engages before measurement operation can continue.

3. Place MODE selector to AC (MEASURE). If interlock circuit is activated (RESET push button lighted) it will be necessary to either press the RESET button or advance the COARSE AMPLITUDE control one step and then return it to zero in order to deactivate the circuit.

4. Energize the voltage source which is to be calibrated. Measurement may be performed in either one or two ways: The source may be adjusted to a desired level and the resultant voltage read from the Model 829G display, or the source may be adjusted until the Model 829G display indicates a desired value and then the voltage indication of the source noted. NOTE: The Model 829G readout may lag a change of amplitude adjustment of the source by a second or two. In some instances it may be desirable to retain the Model 829G display while the indication is noted and manually recorded. This can be achieved by placing the READOUT switch in HOLD position, at which time the indication present at the instant the switch is closed will be retained. Return the READOUT switch to NORMAL after completion of observations.

[redacted]

Overrange

Do not exceed the rated full-scale range voltage by more than 40%. Failure to observe this precaution can result in damage to the Model 829G components.

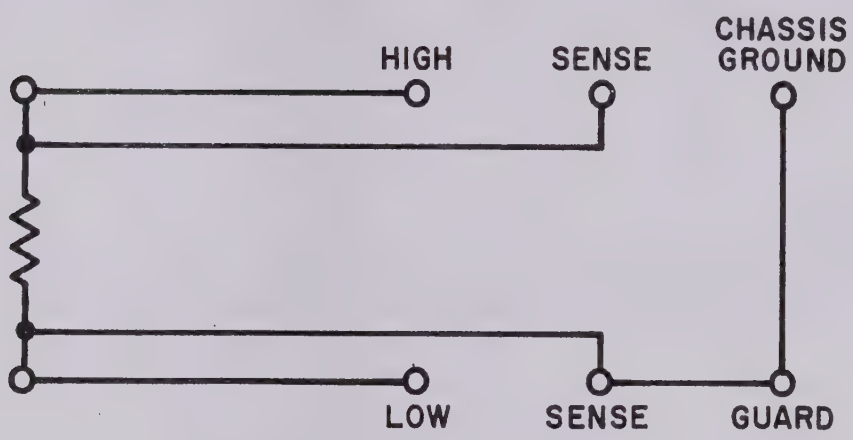
OHMS AC

Full-Scale Ranges: 0 to 0.01, 0.1, 1, 10, 100 ohms (plus 40% overrange)

Accuracy: (for 100% to 10% of full-scale range)

±(0.05% of range +0.05% of reading) +100μ ohms

Terminal Connections:



OPERATIONAL PROCEDURE

1. Set DISPLAY selector to ZERO, FUNCTION selector to OHMS MEASURE (low range), RANGE selector to range commensurate with resistance which is to be measured, MODE selector to OFF, READOUT switch to NORMAL, AMPLITUDE SWITCH to NORMAL, AMPLITUDE controls full counter-clockwise and frequency selector to desired frequency.

2. Connect resistor which is to be measured to the Model 829G terminals as shown in illustration above. Lower protective plexiglass shield until its associated interlocking switch engages. Place MODE selector in AC (SUPPLY) position. Press RESET button or advance COARSE AMPLITUDE control one step and then return it to zero to de-activate interlock circuit. Model 829G display should indicate zero. Set DISPLAY switch to READ. Set FUNCTION selector to AMPERES, advance COARSE AMPLITUDE control one step and return to zero, and adjust COARSE and MED/FINE AMPLITUDE controls until Model 829G display indicates full-scale value of current range. For example, if the RANGE selector is in the 10 ohms position, the applied current through the resistor will be 10.000 milliamperes. Return FUNCTION selector to OHMS MEASURE (low range), press RESET and read resistance value directly from Model 829G display. NOTE: Do not readjust the AMPLITUDE controls after switching the FUNCTION selector from AMPERES to OHMS MEASURE. Each time the FUNCTION selector position is changed it will be necessary to press the RESET button to de-activate the interlock circuit.

NOTES

If Model 829G display does not indicate zero (±3 counts) in Step 2 with DISPLAY selector in ZERO position, it will be necessary to reset the electrical zero of the digital display. See Calibration Procedure section of this manual for adjustment technique.

The current applied through the resistor being measured will be that value adjacent to the range noted on the panel, i.e. 10M ohms - 10A; 100M ohms- 1A; 1 ohm - 100 mA; 10 ohms - 10 mA; and 100 ohms - 1 mA.

AMPERES DC

Full-Scale Ranges: 0 to 100μA, 1 mA, 10 mA, 100 mA, 1A, 10A (plus 40% overrange)

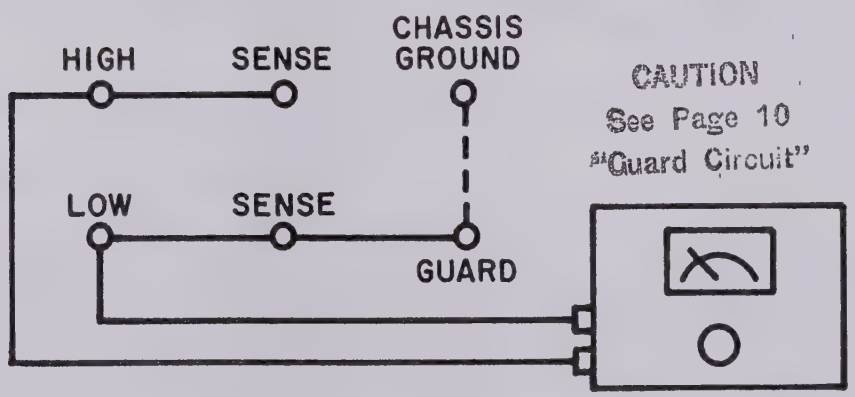
Range Burdens: (excluding connecting leads)

Full-Scale Range	Ohms	Burden Volts*	VA*
100μA	21k	2.1	0.00021
1 mA	2.1k	2.1	0.0021
10 mA	210	2.1	0.021
100 mA	21.2	2.1	0.21
1A	2.13	2.13	2.13
10A	0.2	2.13	21.3

** Indicates load at full-scale range (not at overrange conditions). Do not exceed full-scale range value by more than 40%. Excess current can result in damage to precision shunts.*

TERMINAL CONNECTIONS

Dashed lines indicate optional connections
Solid lines indicate mandatory connections



Current Source Being Calibrated.

OPERATIONAL PROCEDURE

1. Place READOUT switch in NORMAL position, MODE selector to OFF, AMPLITUDE controls full counterclockwise, AMPLITUDE switch in NORMAL, FUNCTION selector to AMPERES, RANGE selector to desired range, and DISPLAY selector to READ position. FREQUENCY selector is not used in this mode of operation.

2. Connect the de-energized source which is to be calibrated to the Model 829G terminals (see illustration, page 31). Raise protective plexiglass shield to facilitate connecting leads. Shield must be lowered until its associated interlocking switch engages before measurement operation can continue.

3. Place MODE selector to DC (MEASURE). If interlock circuit is activated (RESET push button lighted) it will be necessary to either press the RESET button on advance COARSE AMPLITUDE control one step and then return it to zero in order to de-activate the circuit.

4. Energize the current source which is to be calibrated. Measurement may be performed in either one of two ways: The source may be adjusted to a desired level and the resultant current read from the Model 829G display, or the source may be adjusted until the Model 829G display indicates a desired value and then the current indication at the source noted. NOTE: The Model 829G readout display may lag an amplitude change in the source by a second or two. In some instances it may be desirable to retain the Model 829G display reading while the indication is noted and manually recorded. This can be achieved by placing the READOUT switch in HOLD position at which time the readout present at the instant the switch is closed will be retained. Return the READOUT switch to NORMAL after completion of observations.

PRECAUTIONARY NOTE

Overrange

Do not exceed full-scale rated current by an amount greater than 40% of full-scale range. Failure to observe this precaution can cause damage to the Model 829G circuitry.

VOLTS DC

Full-Scale Ranges: 0 to 0.1, 1, 10, 100, 1000 volts (plus 40% overrange)

Input Impedance: 10k ohms/volt

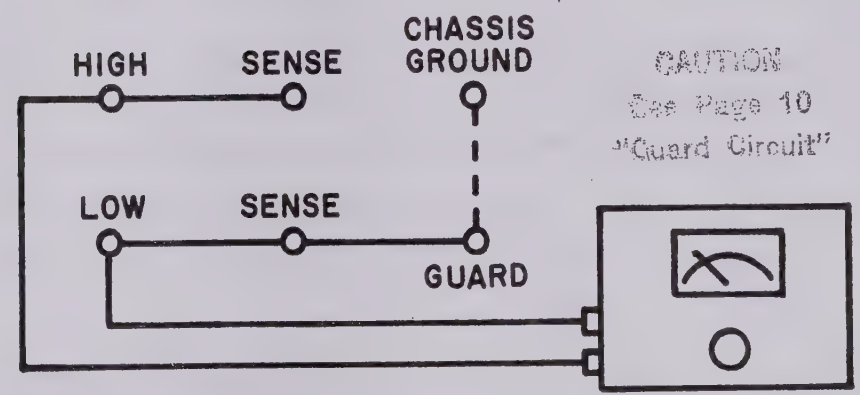
Accuracy: (for 100% to 10% of full-scale)

±(0.02% of range +0.03% of reading) +0.1mV

Caution: Do not exceed full-scale rated input by more than 40%. Failure to observe this precaution can result in damage to the Model 829G.

TERMINAL CONNECTIONS

Dashed lines indicate optional connections.
Solid lines indicate mandatory connections.



Voltage Source Being Calibrated.

OPERATIONAL PROCEDURE

1. Place READOUT switch in NORMAL position, MODE selector to OFF, AMPLITUDE controls full counterclockwise, AMPLITUDE switch to NORMAL, FUNCTION selector to VOLTS, RANGE selector to desired range and DISPLAY selector to READ position. The FREQUENCY selector is not used for this mode of operation.

2. Connect the de-energized source which is to be measured to the Model 829G terminals (see illustration above). Raise protective shield to facilitate connecting leads. The shield must be lowered until its associated interlocking switch engages before measurement operation can continue.

3. Place MODE selector to DC (MEASURE). If interlock circuit is activated (RESET push button lighted) it will be necessary to either press the RESET button or advance COARSE AMPLITUDE control one step and then return it to zero in order to de-activate the circuit.

4. Energize the voltage source which is to be calibrated. Measurement may be performed in either one of two ways: The source may be adjusted to a desired level as indicated by its readout and the resulting voltage read on the Model 829G display, or the source may be adjusted until the Model 829G display indicates a desired value and the source indicator then noted for indication. NOTE: The Model 829G display may lag a change in amplitude adjustment of the source by a second or two. In some instances it may be desirable to retain the Model 829G reading while the indication is noted and manually recorded. This can be achieved by placing the READOUT switch in HOLD position at which time the readout present at the instant the switch is closed will be retained. Return READOUT switch to NORMAL at completion of observations.

PRECAUTIONARY NOTE

Overrange

Do not exceed full-scale rated voltage by more than 40%. Failure to observe this precaution can cause damage to the Model 829G circuitry.

OHMS DC

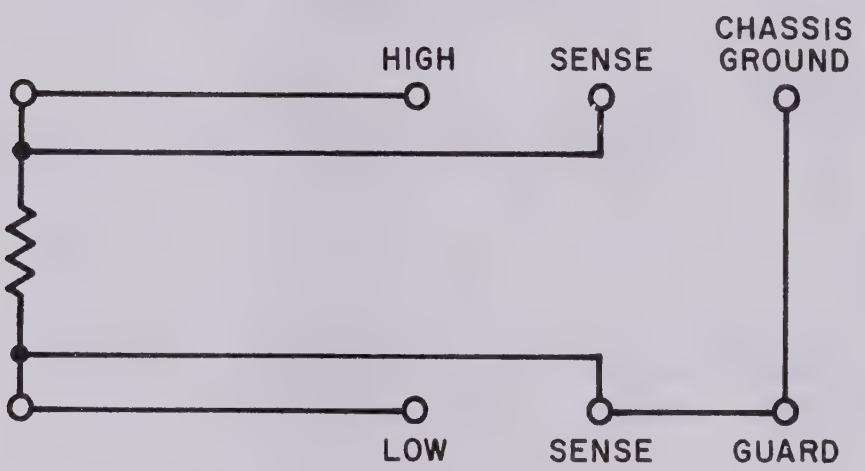
Low Ranges

Full-Scale Ranges: 0 to 0.01, 0.1, 1, 10, 100 ohms (plus 40% overrange)

Accuracy: (for 100% to 10% of full-scale range)

±(0.02% of range +0.03% of reading) +100μ ohms

TERMINAL CONNECTIONS



OPERATIONAL PROCEDURE

1. Set DISPLAY selector to ZERO, FUNCTION selector to OHMS MEASURE (low ranges), RANGE selector to range commensurate with resistance which is to be measured. MODE selector to OFF, READOUT switch to NORMAL, AMPLITUDE SWITCH to NORMAL, AMPLITUDE controls full counter-clockwise and FREQUENCY selector to 400 Hz.
2. Connect resistor which is to be measured to the Model 829G terminals as shown in illustration above. Place MODE selector to +DC (SUPPLY) position. Press RESET button or advance COARSE AMPLITUDE control one step and then return it to zero to de-activate the interlock circuit. Model 829G display should indicate zero (±3 counts). Set FUNCTION selector to AMPERES and advance COARSE AMPLITUDE control one step and return to zero. Set DISPLAY selector to READ position. Adjust COARSE and MED/FINE controls until Model 829G display indicates full-scale. For example, if RANGE selector is set to 10 ohms range, full-scale current will be 10.000 milliamperes. Return FUNCTION selector to OHMS MEASURE (low ranges), press RESET and read resistance value directly from Model 829G display. NOTE: Do not readjust Model 829G AMPLITUDE controls after switching FUNCTION selector from AMPERES to OHMS MEASURE. Each time FUNCTION selector position is changed it will be necessary to press RESET button in order to re-activate the interlock circuit.

NOTES

If Model 829G display does not indicate zero (±3 counts) in Step 2 with DISPLAY selector in ZERO position, it will be necessary to reset the electrical zero of the digital display. See Calibration section of this manual for adjustment procedure.

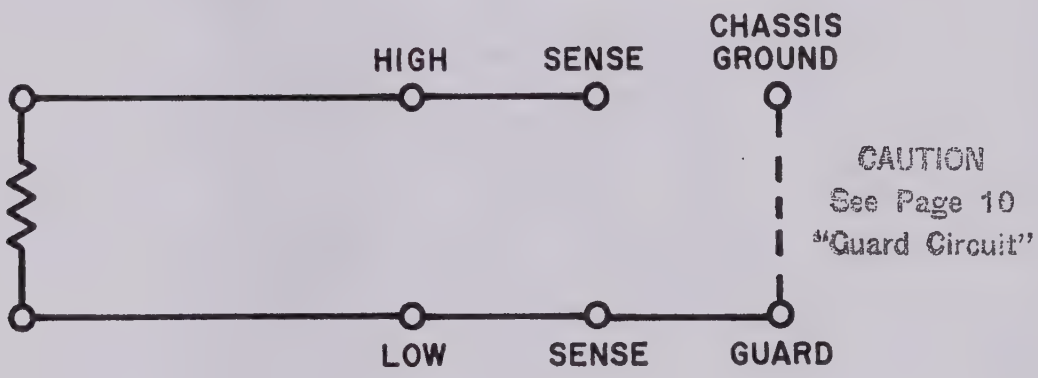
The current applied through the resistor being measured will be that value adjacent to the range noted on the panel; i.e. 10M ohms - 10A; 100M ohms - 1A; 1 ohm - 100 mA; 10 ohms - 10 mA; and 100 ohms - 1 mA.

OHMS DC
High Ranges

Full-Scale Ranges: 0 to 1k, 10k, 100k, 1M, 10M

Accuracy: ±(0.02% of range +0.03% of reading) +0.1 ohm (to 100k)
±(0.02% of range +0.1% of reading) (to 1 Megohm)
±(0.02% of range +0.2% of reading) (to 10 Megohms)

TERMINAL CONNECTIONS



OPERATIONAL PROCEDURE

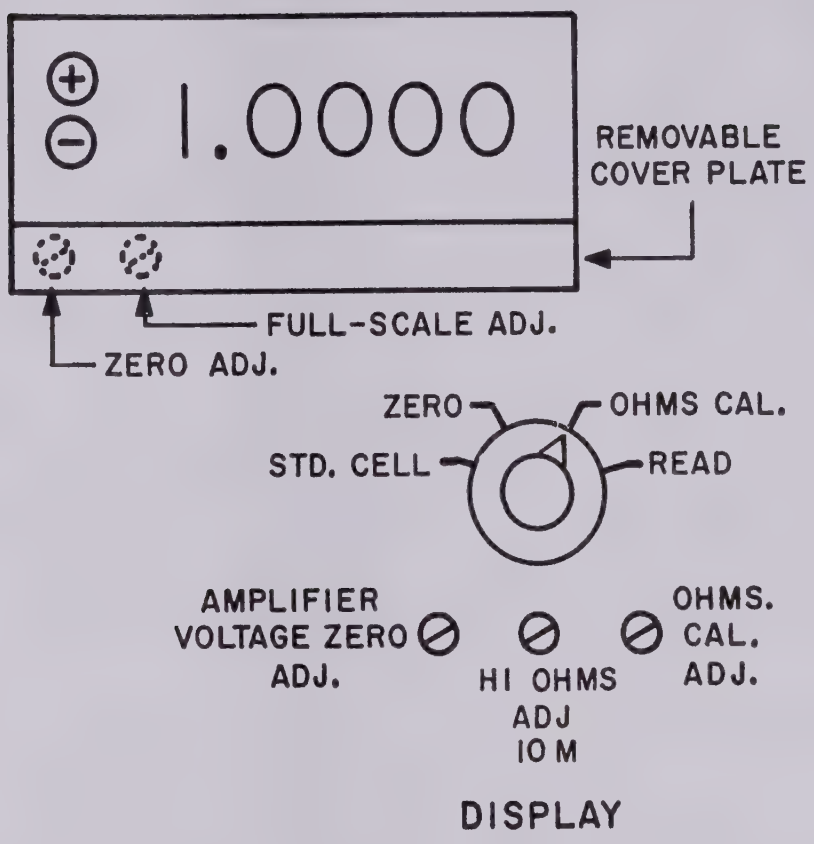
1. Place MODE selector to OFF, FUNCTION selector to OHMS MEASURE (high ranges), RANGE selector to range commensurate of resistance which is to be measured, READOUT switch to NORMAL, AMPLITUDE controls full counterclockwise, AMPLITUDE switch to NORMAL, FREQUENCY selector to 400 Hz (DC) and DISPLAY selector to zero.

2. Connect resistor which is to be measured to Model 829G terminals as shown in illustration above. Place MODE selector to DC (MEASURE) position. Model 829G readout should indicate zero (±3 counts), if zero ±3 last place digit is not indicated, see Calibration section of this manual for adjustment procedure.

3. Place DISPLAY selector in OHMS CAL position. Model 829G display should indicate full-scale, i.e. 10.000 or 1.000, etc. (If full-scale reading is not evident, see Calibration section of this manual for adjustment procedure.)

4. Place DISPLAY selector to READ position. Model 829G display will indicate value of resistance.

CALIBRATION



MODEL 829G SELF CALIBRATION

Allow equipment to warm-up at least one-half hour prior to making any calibration checks.

1. Set DISPLAY switch to ZERO and MODE to +DC. Adjust pot in bottom left side corner of DPM for toggle of plus and minus lights. Disregard digital reading of DPM.

2. Set DISPLAY switch to STD CELL and connect a STD CELL to terminals on the rear of the measurement module, if unit is equipped with a STD CELL switch to INTERNAL CELL. Set POLARITY switch (rear of unit on measurement module) to REVERSE. Adjust DPM negative full-scale pot located to right of zero pot for certified cell reading. Set POLARITY switch to NORMAL and check positive full-scale. Positive full-scale pot is located on the right side of the DPM (inside unit) and is preset at factory.

3. Set DISPLAY switch OHMS CALIBRATE. Set FUNCTION to HI OHMS MEASURE (1K-10K-100K-1M). Short the HIGH terminal to the LOW terminal. Using the third pot from left under the DISPLAY switch, adjust to read 1.000.

This adjustment should be the same for (1K-10K-100K-1M-10M). This adjustment has no effect on the low ohms measure. The full-scale accuracy of the 10 meg range is set by using a precision (0.03%) 10 meg resistor and setting the second pot from left under the DISPLAY switch.

4. Set DISPLAY switch to READ, FUNCTION switch to VOLTS (RANGE 100 mV, COARSE zero) and adjust first pot from left under DISPLAY switch for the toggle of plus and minus light. Again disregard the digital reading of the DPM, if any. Note there will be a two digit reading if same controls are setup on AC volts zero. This threshold noise will not effect accuracy of output or indication either at full-scale or down scale.

When the Model 829G is furnished with an internal standard cell, the instrument is effectively a self-calibrateable unit (with the exception of the 10 megohm range).

When the Model 829G is not furnished with an internal standard cell, an external cell (either saturated or unsaturated type) may be used as a calibration reference source. The external cell is connected to the pin jacks marked STD. CELL + and - located on the panel of the Measurement Module located at the center of the Model 829G rear panel. Be certain to note polarity and connect external cell accordingly. The value of the cell should be known to within ±0.01%.

MAINTENANCE

The Model 829G is basically a combination of four major circuit sections: Power Supply, Digital Panel Meter, Measurement Module, and Oscillator. If a problem exists, it is suggested that a preliminary check of the power supplies be taken. The following voltages apply.

REFERENCE — Negative side of C1 – Common
Positive side of C1 – Approx. +70V DC unreg.
Negative side of C2 – Approx. -70V DC unreg.
Cathode of CR5 – Approx. +15V DC
Cathode of CR6 – Approx. -15V DC

The following voltages are supplied by the Digital Panel Meter. Use extreme caution when measuring these voltages, as they are not protected and a short can cause damage to the internal circuitry of the DPM.

Change REFERENCE to analog ground, pin 2J located at rear of DPM.

Pin 2K – +28V DC
Pin 2M – -28V DC

The following chart should be useful for locating a problem but does not exclude other circuitry which might be the cause of a particular problem.

Troubleshooting Guide

SYMPTOM	PROBABLE CAUSE	CHECK	POSSIBLE CORRECTION
RESET indicator remains lighted continuously or its operation appears erratic.	MODE selector in OFF position.		Place MODE selector to one of its operational positions.
	RANGE, FUNCTION or MODE selectors not in their detented positions.		Rotate selector knobs to be certain switches are seated in detent positions.

SYMPTOM	PROBABLE CAUSE	CHECK	POSSIBLE CORRECTION
RESET indicator remains lighted continuously or its operation appears erratic.	COARSE AMPLITUDE control in zero position.		Rotate control several steps clockwise and return to zero.
	Plexiglass terminal shield not activating its associated switch S10.	Audible click should be heard as shield is raised or lowered.	Switch push rod may be binding against panel. S10 may be defective. Adjust or replace as required.
	Heat sink temperature thermostat open due to prolonged overload conditions or defective thermostat.	S11	Allow instrument to cool for several minutes until thermostat automatically resets. Replace if defective.
	Overvoltage sensor shorted. Capacitor C14 defective.	SCR (CR-15) on circuit board located on underside of instrument.	Replace if defective.
	Relay K1 not operating or operating erratically.	Relay K1 coil and supply current.	Pull-in current 8 mA, drop-out current 3.5 mA. Nominal operating current approx. 5.5 mA. Resistor R53 is current limiting component for this relay.
	Spurious oscillation in power amplifier/preamplifier.	Connect oscilloscope to front panel LOW terminal and terminals 1 - 2 on TB2 (rear of instrument). Check for r.f. oscillation.	Roll-off capacitor C110. May require selected value to cancel spurious oscillation.

SYMPTOM	PROBABLE CAUSE	CHECK	POSSIBLE CORRECTION
Front panel thermal circuit breaker releases repeatedly with 829G operating below its rated output.	Defective breaker.	CB1	Replace
	Change of breaker sensitivity.	CB1	Adjust set screw on rear of breaker for lower sensitivity (CCW rotation raises current rating).
	Excessive idle current through power amplifier.	Voltage drop across each 5 ohm resistor R12 thru R17 not to exceed 2V DC.	Adjust current limiting resistor R7 until drop across each of the 5 ohm resistors is approx. 2V DC.
	Preamplifier roll-off shift causing spurious oscillation.	Remove shorting strap from pins 1 - 2 on TB#2 (rear panel of instrument). If circuit breaker can then be reset, preamplifier or power amplifier is suspect.	Shorted or leaky transistors Q1 thru Q8. Replace if necessary. Adjust value of C110 or R119 on preamplifier board or check for and replace any defective components on preamplifier board.
Reset circuit does not operate (i.e. RESET lamp does not glow and relay K1 does not drop out) when AMPLITUDE controls are run to full maximum in any voltage range with output terminals open-circuited.	CR15 and associated circuitry.	Check CR15 and visual indication of operation on vacuum spark gaps E1, E2, or E3.	Replace defective component.

SYMPTOM	PROBABLE CAUSE	CHECK	POSSIBLE CORRECTION
Panel meter reading indicates 14000, regardless of AMPLITUDE control-adjustment.	READOUT switch locked in HOLD or PRINT COMMAND position.	READOUT switch.	Place switch to NORMAL.
	Measurement Module not fully seated in its associated socket.		Tighten Module slotted head seating shaft located on Module panel.
	Loose plug-in board in DPM unit.	DPM.	Remove DPM cover and seat all boards and I.C.'s.
	Defective DPM.		Replace DPM or service per DPM manual supplied with instrument.
DPM zero adjustment does not allow DPM to be set to zero with DISPLAY selector in ZERO position.	Excessive heat rise in DPM.	Model 829G circulation fan or associated plug.	Loose or defective plug or defective fan. Tighten or replace as necessary.
	Defect in DPM.		See DPM Instruction Manual supplied with instrument.
AMPLIFIER VOLTAGE ZERO adjustment fails to achieve zero DPM indication when following procedure described under (4) of Calibration Procedure.	Defective Operational Ampli-	Op-Amp. IC301.	Replace if defective.
	Operational Amplifier IC301 characteristics change.		Adjust R344. Trim resistor value by replacing resistor with units having adjacent values (i.e. 510 ohms or 420 ohms).

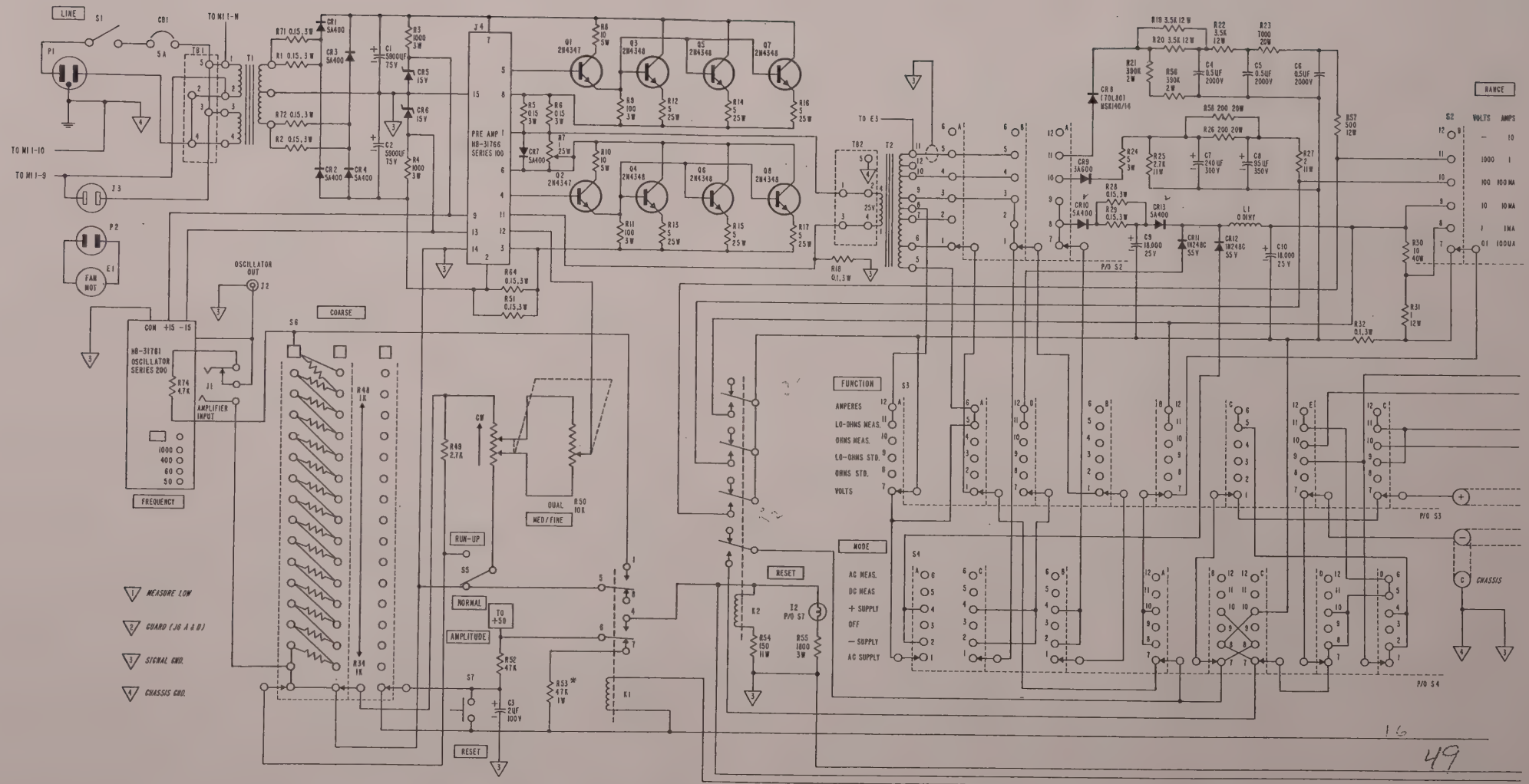
SYMPTOM	PROBABLE CAUSE	CHECK	POSSIBLE CORRECTION
Insufficient output.	Defective transistors in power amplifier.	Check for peak-to-peak signal level of not less than 60V on pins 1-2 of TP2.	Replace transistors.
	Low DC voltages to amplifiers.	EMF levels from DC power supplies as noted in initial steps of this maintenance section.	Locate faulty component and replace as necessary.
	Defective signal transformer or its associated circuitry.	Transformer T2 and associated wiring and components.	Repair or replace as required.
All DC and AC voltage ranges out of tolerance.	Defective voltage sense resistor.	Value of R339 plus associated trimming resistor should be 10K ohms ±0.01%.	Replace as required.
All DC and AC current ranges out of tolerance.	Defective current sense resistor.	Value of R342 plus associated trimming resistor should be 1111.1 ohms ±0.01%.	Replace as required.
All AC current ranges out of tolerance.	Resistor R348 requires adjustment.	Adjustment of R348.	Remove top cover of 829G. With instrument adjusted for 1.0000 ampere output on 1 ampere range adjust R348 for DPM indication of 1.0000 (400 Hz frequency).

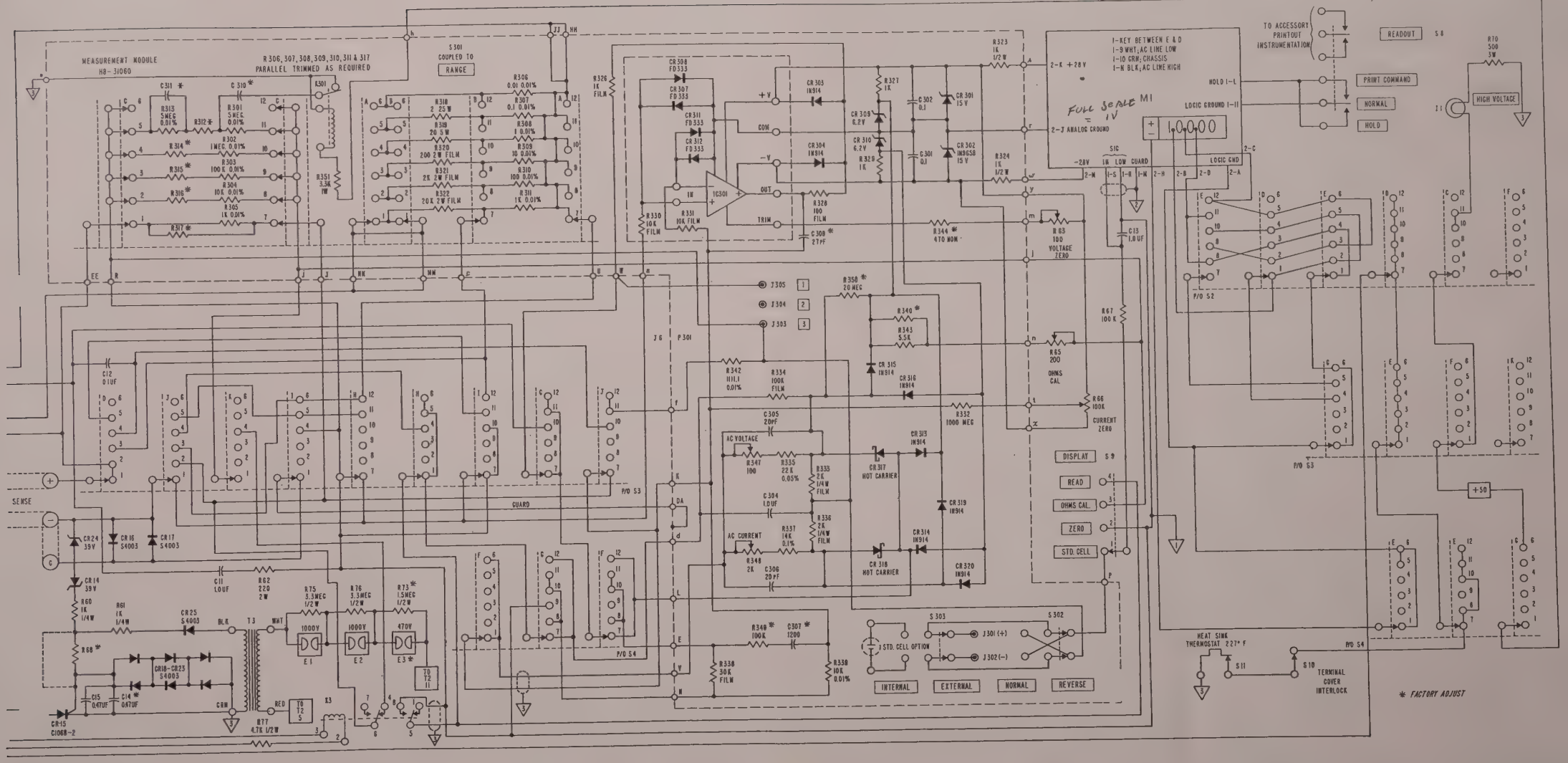
SYMPTOM	PROBABLE CAUSE	CHECK	POSSIBLE CORRECTION
All AC voltage ranges out of tolerance.	Resistor R347 requires adjustment.	Adjustment of R347.	Remove top cover of 829G. With instrument adjusted for 100.00 volt output on 100 volt range, adjust R347 for DPM indication of 100.00 volts (400 Hz freq.).
Output voltage correct when MODE selector set to +DC but erroneous when set to -DC.	Insulation breakdown between low side of circuitry and ground.	C7 - C10, CR11 & CR12 and associated wiring and switches for short.	Repair shorted condition or replace defective component.
Calibration out of tolerance but standard resistors measure correctly.	Meter + and −.	Standard cell + and −.	Adjust meter. See DPM Manual.
	Defective Operational Amplifier or associated component.	IC301. Check for spurious oscillation at terminals 1 & 3 on Measurement Module panel.	Replace IC301 if found defective. If oscillation is apparent on both upper and lower portions of waveform select appropriate value of capacitor for C309. If oscillation appears only on upper portion of waveform select appropriate value for C305. If oscillation is apparent only on lower half of waveform select an appropriate value of capacitance for C306.
	Defective preamplifier.	Check TB1 terminals 1 & 2 to chassis (rear of instrument) for spurious oscillations.	If oscillation is apparent on upper half of waveform, increase C111. If oscillation is apparent on lower half of waveform, check C105, C106, C109 & R116 on preamplifier.

SYMPTOM	PROBABLE CAUSE	CHECK	POSSIBLE CORRECTION
One particular range out of tolerance.	Defective resistive component caused by over dissipation when operating instrument in its MEASURE mode (i.e. excessive current or voltage applied).	Appropriate precision resistor. See procedure under Precision Resistors, page 23 of this manual.	Replace as required.
Output value of voltage current or resistance differs from selected range by a factor of 10.	Misalignment between front section of RANGE selector rear section.	Coupler between front (panel) section and rear (Measurement Module) section.	Remove Model 829G top cover. Remove Measurement Module from instrument. Rotate RANGE selector full CCW (100 mV) position). Rotate switch shaft on front of Measurement Module fully CCW. Replace Measurement Module into Model 829G and observe alignment of coupler. Loosen and reset set screws if necessary.
Output appears on front panel terminals but Model 829G DPM does not indicate.	Loose binding post on front panel or link not in position.	Tightness of terminals and presence of links.	
	READOUT or DISPLAY switch in other than NORMAL position.	READOUT & DISPLAY switch.	Place switch in NORMAL position.
	DPM.	If instrument incorporates internal standard cell, place DISPLAY switch to STD. CELL position. Correct reading indicates DPM satisfactory. An external EMF of approx. 1 volt may also be used.	DPM failure may indicate excessive EMF has been applied. Check EMF applied to DPM by means of a high impedance voltmeter connected in place of DPM input. EMF applied to DPM at full-scale range value is 1 volt.

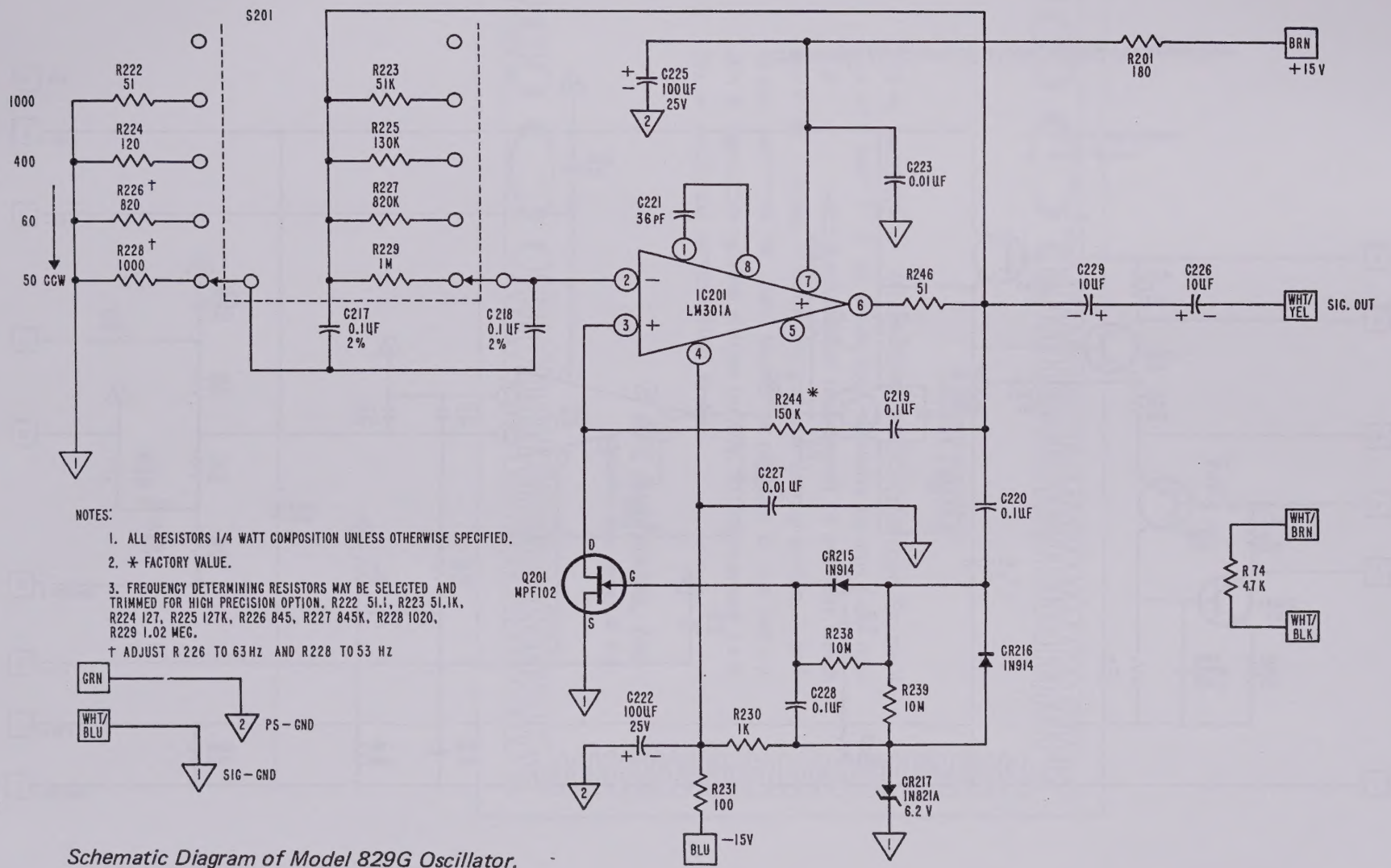
Table of Recommended Spare Parts

SYMBOL DESIGNATION	RFL P/N	RECOMMENDED QUANTITY	DESIGNATION
C4, C5, C6	HA-7710	1	Filter Capacitor: 0.5μF, 2000 volts
CB1	HB-11663	1	Line Circuit Breaker: 5A for 115 volt line
	HA-17310	1	Line Circuit Breaker: 3A for 220 volt line
CR15	HA-26927	1	C106B-2 Silicon Controlled Rectifier
CR103, CR104, CR215, CR216 CR303, CR304, CR313, CR314 CR315, CR316, CR319, CR320	HA-24325	2	Diode: Type 1N914
CR317, CR318	HA-31025	1	Hot Carrier Diode
IC101	H-0620-27	1	Operational Amplifier:(pre-amp) LM-301-A
IC201	H-0620-7	1	Operational Amplifier:(oscillator) u709G
R106	H-1100-393	1	Parasitic Suppressor Resistor: 10 ohms, 5 W
S7	HA-34142	1	Reset Indicator and Switch
S11	HA-31759	1	Heat Sink Thermostat: 227°F. operating point


LINE
S1
CB1
TO M1 1-M
P1
S A
TB1
T1
TO M1 1-10
TO M1 1-9
J3
P2
E1
FAN MOT
R71 0.15,3W
R1 0.15,3W
R72 0.15,3W
R2 0.15,3W
CR1 5A400
CR3 5A400
CR2 5A400
CR4 5A400
CR5 15V
CR6 15V
C1 5900UF 75V
C2 5900UF 75V
R3 1000 3W
R4 1000 3W
J4
PRE AMP I HB-31766 SERIES 100
R5 015 3W
R6 015 3W
R7 25W
CR7 5A400
R64 0.15,3W
R51 0.15,3W
Q1 2N4347
Q2 2N4347
Q3 2N4348
Q4 2N4348
Q5 2N4348
Q6 2N4348
Q7 2N4348
Q8 2N4348
R8 10 5W
R9 100 3W
R10 10 5W
R11 100 3W
R12 5 25W
R13 5 25W
R14 5 25W
R15 5 25W
R16 5 25W
R17 5 25W
R18 0.1,3W
TO E3
T82
T2
25V
OSCILLATOR OUT
J2
CON +15 -15
HB-31781 OSCILLATOR SERIES 200
R74 4.7K
J1
AMPLIFIER INPUT
1000
400
60
50
FREQUENCY
S6
COARSE
R48 1K
R34 1K
R49 2.7K
CW
DUAL
R50 10K
MED/FINE
RUN-UP
S5
NORMAL
AMPLITUDE
TO +50
R52 47K
S7
C3 2UF 100V
RESET
R53* 47K 1W
K1
MEASURE LOW
GUARD (J6 A & B)
SIGNAL END.
CHASSIS END.
R10 3.5K 12W
R20 3.5K 12W
R22 3.5K 12W
R23 7000 20W
R21 390K 2W
R56 390K 2W
C4 0.5UF 2000V
C5 0.5UF 2000V
C6 0.5UF 2000V
CR8 (70L80) MSA140/16
R58 200 20W
R26 200 20W
R57 500 12W
CR9 5A600
R24 5 3W
R25 2.7K 11W
C7 240 UF 300V
C8 95UF 350V
R27 2 11W
R28 0.15,3W
R29 0.15,3W
CR10 5A400
CR13 5A400
C9 18,000 25V
CR11 1N248C 55V
CR12 1N248C 55V
L1 0.01HY
C10 18,000 25V
R30 10 40W
R31 12W
R32 0.1,3W
P/O S2
RANGE
S2
VOLTS
AMPS
10
1000
1
100
100 MA
10
10 MA
1
1 MA
0.1
100 UA
FUNCTION
S3
AMPERES
LO-OHMS MEAS.
OHMS MEAS.
LO-OHMS STD.
OHMS STD.
VOLTS
P/O S3
MODE
S4
AC MEAS.
DC MEAS
+ SUPPLY
OFF
- SUPPLY
AC SUPPLY
P/O S4
CHASSIS
R2
R54 150 11W
T2 P/O S7
R55 1800 3W
16
49



Schematic Diagram of Model 829G AC/DC Calibration Standard.

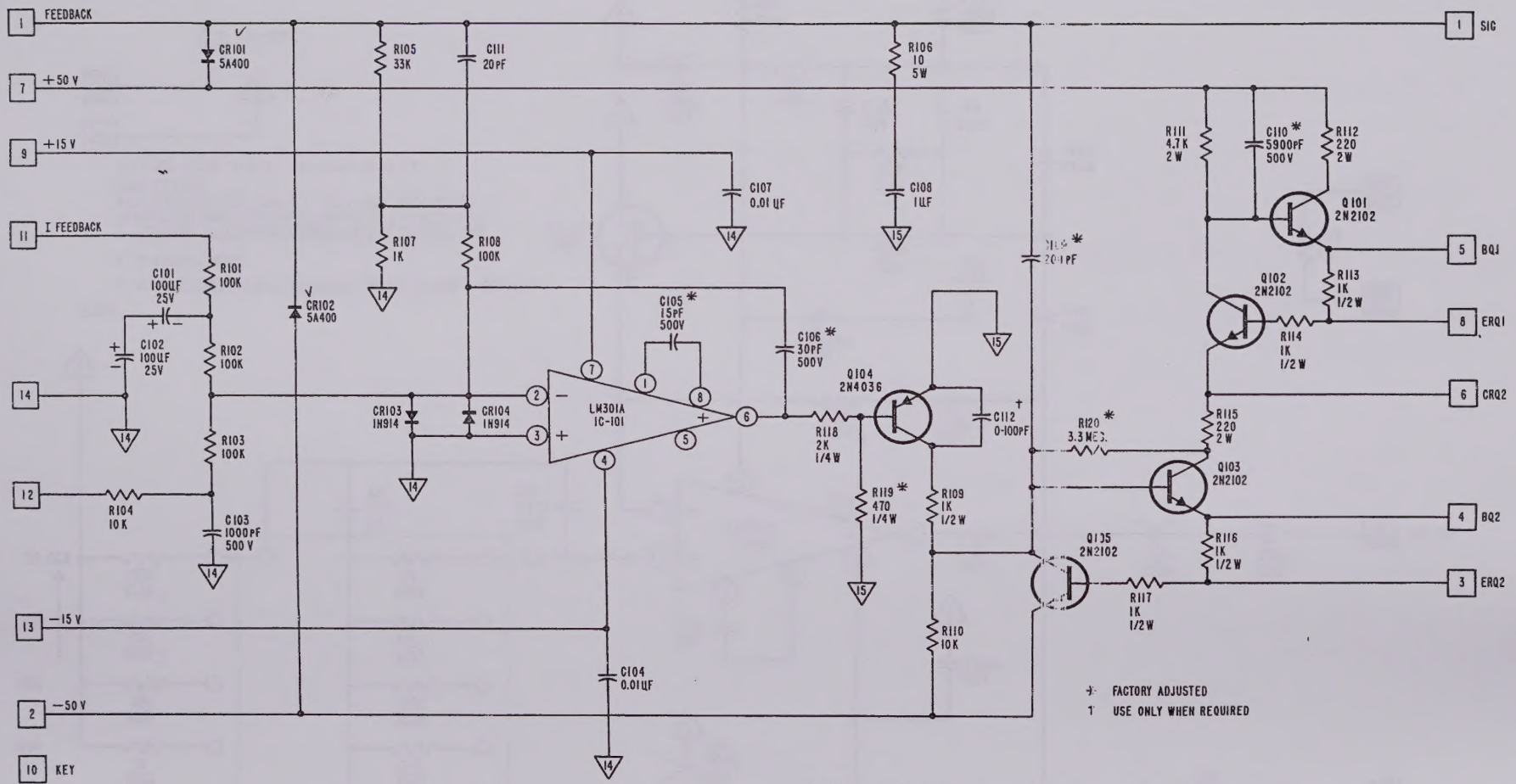


NOTES:

1. ALL RESISTORS 1/4 WATT COMPOSITION UNLESS OTHERWISE SPECIFIED.
2. * FACTORY VALUE.
3. FREQUENCY DETERMINING RESISTORS MAY BE SELECTED AND TRIMMED FOR HIGH PRECISION OPTION. R222 51.1, R223 51.1K, R224 127, R225 127K, R226 845, R227 845K, R228 1020, R229 1.02 MEG.

† ADJUST R 226 TO 63Hz AND R228 TO 53 Hz

Schematic Diagram of Model 829G Oscillator.



Schematic Diagram of Model 829G Preamplifier.

Warranty

The Model 829G AC-DC Calibration Standard carries a warranty of twelve months from date of delivery for replacement of any part which fails during normal operation or service. A deficient part should be returned to the factory, shipping charges prepaid, for replacement f.o.b. Boonton, New Jersey.

RFL Industries, Inc.

Boonton, New Jersey, U.S.A.

CERTIFICATE
FOR
MODEL 829G
AC-DC CALIBRATION STANDARD

Serial Number_____

The described instrument was calibrated at RFL Industries, Inc N. J. on at an ambient room temperature of Calibration test covered all ranges provided by the instrument. Instr used in calibration have calibration accuracy traceable to the Natic of Standards either directly or indirectly in an unbroken chain.

Calibration performance of the instrument is guaranteed for a pe year providing interim self-calibration checks are performed in the frequency described in the instruction manual.

*Serial number of standard cell _____

*EMF of standard cell _____ at _____

It is not expected that the calibration of the instrument will than % per ^{o}C change in operating environment.

** Standard cell furnished with instrument as an optional accessory.*

Certified by_____

Date_____

33441